A2D03: Committee on Characteristics of Bituminous-Aggregate Combinations
To Meet Surface Requirements
Chairman: Timothy B. Aschenbrener, Colorado Department of Transportation

Surface Requirements for Bituminous-Aggregate Combinations

REBECCA S. MCDANIEL, *North Central Superpave Center*
SCOTT SHULER, *Lafarge Construction Materials*

Bituminous pavement surfaces must meet special requirements for riding comfort, frictional characteristics, permeability, tire and pavement wear, segregation, raveling, appearance, light reflectance, and noise. The focus of this paper is on the progress the asphalt industry has made to date in addressing these special requirements and the challenges it faces in the future.

STATE OF THE ART

A major change in the asphalt industry in North America is the growing use of the Superpave system for material selection and design of asphalt mixtures. Building on existing knowledge, this system adds new test methods, techniques, and models. The first Superpave pavements were constructed in 1992 and 1993; thus the experience with these new mixtures and their performance is limited. Implementation of the new design system is growing rapidly, with more than 1,300 projects completed in 1998.

Although Superpave dominates asphalt technology in the United States and Canada, in other parts of the world, other technologies have continued to gain interest. One example is the concept of designing and using asphalt mixtures for specific tasks. Although this is not a completely new idea, specialty surface course mixtures have been developed to address specific problems associated with friction, wet weather visibility, noise, and durability. In certain cases, these mixtures and processes carry unique brand names to help identify them in the market.

Binder Selection and Grading

The development of Superpave has led to a new system for selecting and grading asphalt binders, referred to as the Performance Grading (PG) system. The PG system allows for selection of a binder for specific climatic and traffic conditions. Use of this system should result in reduced low-temperature cracking in pavements, improving performance related to moisture intrusion through the cracks. The PG system is also expected to improve the resistance of pavements to rutting by leading to the selection of binders that are stiffer at the high surface temperatures encountered during service. In effect, the PG system is a method for designing the asphalt binder to be used for specific pavement sites. This new system for binder specification and selection has been adopted by 37 states and will likely be implemented by 47 states by 2000.

Aggregate Selection and Grading
Superpave also includes new requirements for aggregate selection and gradation as a part of the overall mixture design system. The goal of these aggregate requirements is to design a strong, stable aggregate structure. Aggregates must meet certain consensus properties of shape and surface texture to help ensure that the aggregate structure is resistant to shear deformation (coarse aggregate angularity and fine aggregate angularity). Shape is also an important consideration during construction because flat and elongated particles may lead to harsh mixtures that are hard to compact or that may break during compaction, producing uncoated surfaces in the mat that may be starting points for stripping and other durability problems. Aggregate cleanliness (lack of a clay coating on the surface, as measured by the sand equivalent value) also can affect performance by affecting the bond between the aggregate and the binder. Additional aggregate properties are also needed to ensure good performance, but these properties must be determined on the local level by the specifying agency (source properties).

Mixture Proportions
Guidance is also provided in the Superpave system on proportioning aggregates and asphalt to produce mixtures. However, aggregate gradings are not bound by limits, which tend to produce specific types of mixtures (e.g., dense graded or open graded). The mix designer is thus allowed more freedom when selecting aggregate gradations. Consequently, high-performance mixtures can now be fabricated without artificial boundaries on the aggregate grading requirements. However, volumetric criteria currently used by Superpave to establish optimum binder content are based on empirical engineering experience developed from fine dense-graded aggregate mixtures. Therefore, when coarse gap-graded mixtures are produced by the Superpave system and dense-graded volumetric criteria are used to obtain optimum binder content, unexpected results may occur. In addition to inconsistencies in design, Superpave mixes can lead to challenges during construction because many mixtures are coarser than historically produced and thus may be more difficult to compact.

Performance
Performance of Superpave mixtures was originally to be predicted by mathematical models using data input from laboratory tests of the mixture. However, these models are still being developed. Consequently, the evaluation of the performance of Superpave mixtures relies on the empirical volumetric criteria of the mixture and physical properties of the aggregates and binders.

Because the system is relatively new, the performance of Superpave mixtures has not been demonstrated over the long term. Information about the performance effects of PG binders and Superpave mixtures needs to be collected, evaluated, and disseminated. The effects on performance of changing various properties, such as the aggregate consensus properties or gradation restrictions, also need to be investigated. The impact of the Superpave system on rutting, flushing, segregation, shoving, and cracking will be of continuing interest to the asphalt industry well into the new millennium. The effects, if any, of the Superpave mix design system on other pavement properties, such as friction and ride quality, are also unknown.

Surface Treatments

Use of PG binders for surface treatments, such as chip seals, also needs to be evaluated. Guidance is needed on selecting an emulsion or other product based on PG binders for these applications. This issue is being addressed by the ASTM emulsion tests subcommittee, which is evaluating whether emulsion testing needs to be changed to accommodate PG binders.

Various surface treatments may be used as maintenance treatments or as alternatives to hot-mix asphalt overlays to restore friction, preserve an existing surface, or improve ride quality. Guidance is needed on how to select the best strategy for improving bituminous surfaces. Although few would argue that chip seals and other cold applied surface seals offer significant value as pavement maintenance techniques, the implications of vehicle damage and tracking of asphalt binders often eliminate a viable process from use. However, as environmental controls become more stringent in urban areas, these cold applied processes will need to be evaluated more thoroughly as potential tools. Life-cycle costs of new and existing technologies, including Superpave, need to be reliably evaluated and compared. Some states and organizations have made progress in evaluating life-cycle costs. Their findings and experiences need to be expanded and communicated to a broader audience of decision makers. Information from outside North America should also be considered for the identification and evaluation of alternative surface types.

Recycling

Recycling of existing asphalt surfaces is a technique with many applications and economic and environmental benefits. Research on how to incorporate hot-mix recycling in the Superpave system is ongoing. This research is not currently evaluating other recycling methods, such as cold recycling or hot-in-place recycling, with PG binders.

Safety

Safety will continue to be a major concern of specifying agencies. Asphalt pavement surfaces need to provide adequate, long-lasting frictional properties; a non-rutted profile to prevent water accumulation and hydroplaning; and resistance to bleeding to maintain safety. Superpave technology is expected to help provide a rut-resistant surface and a long service life, but other surface types, such as stone matrix asphalts (SMAs), may also serve that purpose. Open-graded friction courses have been shown to provide good rut and crack resistance in many applications. Some coarse Superpave surfaces may also result in improved macrotexture and reduced spray, but they have not been evaluated to date. In fact, in some locations, coarse Superpave mixtures have rutted and raveled. This poor performance may be caused by the current method of determining minimum asphalt content through voids in the mineral aggregate. Therefore, development of ultrathin, open-graded, SMA and “quiet” asphalt surfaces may be necessary by other means. Superpave has already made great strides in dense-graded mixture technology, but the system will require significant modification to be used for other types of mixtures.

Although open-graded asphalt mixtures have been used extensively throughout the world, relatively catastrophic raveling failures have occurred in some locations. In some cases, moratoriums have been placed on open-graded friction courses because of lack of confidence in their success, despite the significant advantages of these surface mixtures.

Surface-Generated Noise

Concern about noise in the United States and in other parts of the world is growing. As urbanization spreads, noise becomes an issue, even for formerly rural areas. A wealth of information from Europe is available on the noise generation from different pavement surfaces, and a recent National Cooperative Highway Research Program *Synthesis of Highway Practice* (*1*) addressed this issue. More work is needed to investigate and compare noise generated from various surface types, including both new and existing technologies. For example, open-graded mixes offer reduced noise generation. Will coarse-textured Superpave mixtures offer similar improvements? What effect, if any, do various surface treatments have on noise generation?

CHALLENGES

Superpave may be the greatest challenge facing the asphalt industry today, but it is certainly not the only one. Regardless of the rehabilitation method or design method used, asphalt pavements must demonstrate adequate durability, improved service lives, and favorable life-cycle costs to maintain market share. Other challenges pertain to information exchange, training and education, performance, and project delivery.

Information Exchange

Many of the issues of interest to the asphalt industry relate to evolving technologies. For example, Superpave certainly will evolve or be refined as experience with the system accumulates. Noise is another example of an issue with which most civil engineers are unfamiliar, but that is becoming more important.

Practical information on technological refinements and advancements needs to be transferred expeditiously to practitioners and decision makers, and information on emerging technologies and research needs to be shared among researchers.

An effort needs to be made to expand this exchange of information to other levels of government, especially local agencies; other government agencies, such as the Federal Aviation Administration; and private industry, especially consultants. As privatization of many of the functions of departments of transportation continues, so does the need for private industry to be knowledgeable about the latest technologies.

Training and Education

Related to the need for the exchange of up-to-date information is the need to inform a growing audience about the various issues of interest to the Committee on Characteristics of Bituminous-Aggregate Combinations to Meet Surface Requirements. The most obvious example is, again, Superpave, but safety, noise, and other issues are also important.

Practitioners and decision makers need to be informed about emerging technologies. As the workforce ages and retires, new practitioners need to be educated in the state of the art and upcoming developments. The education of undergraduate and graduate engineering students, as well as the training of new technicians and superintendents, will be required.

Performance

The past 20 years have seen enormous changes in the loads applied to pavements by traffic. The increased stresses have exacerbated performance problems in surfaces that had historically performed well. It is well known that the only constant is change. Future changes in traffic loadings can be expected to further increase the stresses pavements must withstand. The asphalt industry needs to remain vigilant in identifying surface-related problems and the means to correct or lessen those problems.

Project Delivery

There is a need to increase the knowledge of both contractors and agencies to allow contractors a greater share of the responsibility, but also a proportionate share of the reward for quality and performance of pavements. The move toward design-build and the many other forms of privatization and long-term warranties enabled by the Intermodal Surface Transportation Efficiency Act of 1991 and the Transportation Equity Act will require contractors in the United States to widen their innovative skills to materials and design technology. This change will not reduce the overall innovative nature of the U.S. system, but broaden it as research and development programs are added to highway contracting.

REFERENCE

1. Wayson, R.L. *NCHRP Synthesis of Highway Practice 268: Relationship Between Pavement Surface Texture and Highway Traffic Noise.* TRB, National Research Council, Washington, D.C., 1998, 85 pp.